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(54) **IMMERSED POUR TUBE HAVING AN EROSION -RESISTANT SLEEVE AND METHOD OF MANUFACTURING THE SAME**

TAUCHGIESSROHR MIT EROSIONSBESTÄNDIGER HÜLSE UND DAZUGEHÖRIGES HERSTELLUNGSVERFAHREN

TUBE DE COULEE IMMERGE PRESENTANT UN MANCHON RESISTANT A L'EROSION ET SON PROCEDE DE FABRICATION

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Description

[0001] This invention relates to metallurgical pour tubes having at least one end of the tube, typically the downstream end, immersed in a pool of molten metal. Pour tubes conduct molten metal from one metallurgical vessel into a mold or another vessel. Examples of such tubes include sub-entry nozzles (SENs) and sub-entry shrouds (SESs), which find particular utility in the continuous casting of molten steel.

[0002] In the continuous casting of sceel, a stream of molten sceel is typically transferred via a pour tube from a first metallurgical vessel into a second metallurgical vessel or mold. The downstream end of the pour tube is immersed in a pool of molten steel, and has sub-surface outlets below the surface level of the molten steel. Such outlets permit the steel to pass from the first vessel to the second vessel or mold without contacting air or slag. This reduces oxidation and limits contamination by slag.

[0003] Pour tubes are typically preheated before use, but although preheated, the tubes are relatively cold compared to the molten steel. The molten steel passing through or around the tube subjects the tube to thermal shock, which can cause the tube to fracture. Consequently, pour tubes typically comprise thermal shock-resistant refractories.

[0004] During casting, an immersed pour tube extends through a layer of slag floating on the molten steel. Slag may comprise glasses, fluxes, mold powders or various impurities. Slag is corrosive, and the pour tube may erode more quickly where it comes in contact with the slag, that is, at the slag-line, than the remainder of the pour tube. The tube may fracture where such erosion occurs. A fractured tube permits slag to mix with the molten steel and also exposes the steel to oxidation. Additionally, a pour tube immersed in a mold often has sub-surface outlets designed to affect flow patterns and crystallization of the molten steel. Loss of the downstream end having the sub-surface outlets may thereby compromise steel quality and, in some cases, may permit breakout in the frozen steel strand issuing from the mold.

[0005] Attempts to prevent erosion of an immersed pour tube involve the use of collars fitted around the pour tube at the slag-line. Such collars, or slag-line sleeves, protect the tube from contact with corrosive slag. The sleeve may move relative to the outside surface of the tube, and permit the sleeve to rise and fall with changes in the molten steel level. A slag-line sleeve may be connected to a mechanism capable of raising or lowering the sleeve in response to melt level. The sleeve may even form a type of crucible surrounding the pour tube. The crucible has at least one opening communicating with a sub-surface outlet in the pour tube.

[0006] Sleeves may also be fixedly attached to the outside of the pour tube. In practice, sleeves have been mortared, threaded, or copressed onto the pour tube. A mortared construction involves cementing an erosion resistant sleeve onto the exterior of a pour tube. Alternatively, a threaded, erosion-resistant sleeve may be screwed onto the outer surface of the tube.

[0007] Copressing involves pressing together two refractory mixes or one refractory mix and a pre-fired component, and then firing into a single piece.

[0008] Slag-line sleeves often comprise erosion-resistant refractories, such as zirconia, zirconia-graphite, silicon nitride, boron nitride, and zirconium diboride. Additional sleeve compositions include magnesia, magnesia-graphite, magnesia-alumina spinels and dense alumina. Unfortunately, such erosion-resistant refractories often have poor thermal shock-resistance. This property is especially detrimental with pour tubes having fixedly attached sleeves. Attempts to improve thermal shock-resistance by modifying the composition of the sleeve, for example, by adding graphite, frequently compromises erosion-resistance.

[0009] As shown in EP-A-737535, encapsulating the sleeve within the body of the pour tube may minimize thermal shock to the sleeve. The encapsulated sleeve lies between an inner and outer ring of thermal shock-resistant material. These rings are believed to absorb the extreme thermal gradients, which diffuse to the sleeve only gradually. Reduced thermal gradients may permit the use of extremely erosion-resistant materials, such as high-density, sintered zirconia. The encapsulated sleeve should continue to protect the pour tube from the slag after the outer ring of thermal shock-resistant material has eroded away. In a particular case, the densification and sintering of the sleeve occurs in situ, under the action of the heat of the molten metal as the nozzle is first used. This densification and sintering are associated with shrinkage. The shrinkage can be accommodated by providing a layer of compressible material adjacent the inner surface of the sleeve. A limitation of the encapsulation of the sleeve, however, is the high thermal expansion of erosion-resistant materials. The encapsulated sleeve will expand more than the body of the pour tube and could cause the pour tube to fracture from the inside out.

[0010] An attempt, also known from EP-A-737535 to overcome this deficiency is a pour tube having an inner and an outer slag-line sleeve. The inner sleeve, made from a highly erosion-resistant material, is completely encapsulated between the pour tube and the outer sleeve. The outer sleeve is made of a material intermediate between the erosion-resistance and thermal expansion of the body and the inner sleeve. The outer sleeve is expected to decrease thermal stresses within the pour tube.

[0011] A need persists for an integral slag-line sleeve in an immersed, metallurgical pour tube that possesses outstanding erosion resistance but resists fracture itself or fracturing the pour tube when exposed to large thermal gradients or high temperatures.

[0012] The present invention describes a pour tube

and a method of manufacturing a pour tube both having an erosion-resistant sleeve. An object of the invention is to produce a pour tube having an erosion-resistant, slag-line sleeve, wherein both the body of the pour tube and the sleeve resist cracking due to thermal shock or thermal expansion. A further object of the invention is to include an internal slag-line sleeve within such a tube.

[0013] In a broad aspect, the article describes a pour tube having a body defining an interior cavity. A sleeve is located within the cavity. The cavity is larger than the sleeve so that an accommodation region is defined between the sleeve and the body. The region is sufficiently large to permit thermal expansion of the sleeve without fracturing the body of the pour tube.

[0014] One aspect of the article describes the accommodation region as a gap, or, alternatively, as containing a compressible material. Another aspect describes the erosion-resistant sleeve as comprising zirconia or magnesia. A further aspect describes the sleeve as copressed with the body of the pour tube. Still another aspect of the invention describes the interior cavity as formed by the interface of the body with a third component.

[0015] One method for making the article of the invention includes coating a sleeve with a spacer material and pressing the coated sleeve within the body of the pour tube to form a pressed piece. The pressed piece can be fired thereby removing at least some of the spacer material and creating an accommodation region. Vents may be provided for the elimination of spacer material. The spacer material is described as comprising a transient or compressible material.

[0016] Another method of producing the article of the invention comprises co-filling a mold with erosion-resistant and thermal shock-resistant particulate refractories. The erosion-resistant refractory is segregated to the slag-line by a guide means and a spacer material is placed adjacent to the erosion-resistant refractory. The filled mold is pressed and fired to create a pour tube having a slag-line sleeve separated from the body by an accommodation region.

[0017] An alternative method of producing the article of the invention describes co-pressing a sleeve of a transient material inside the pour tube at the slag-line. The transient material may then be eliminated to form an interior cavity. A refractory composition is inserted into the cavity and subsequently densified. One aspect of this method describes the refractory composition as an injectable material comprising, for example, a particulate refractory and wax. Alternatively, the refractory composition is described as densifying at temperatures greater than about 1300°C. In either embodiment, an accommodation region is produced after firing.

[0018] Still another method of producing the article of the invention describes mechanically securing an erosion-resistant, sleeve at the slag-line of a pour tube and covering the sleeve with a third component. The third component is described as a refractory piece designed to fit over the sleeve and create an accommodation region when positioned around the sleeve. Alternatively, the third component may be a compressible material, such as a refractory fiber. An aspect of this method uses a fourth component to secure the third component in place.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 shows a prior art pour tube **1** having a body **2** with a slag-line sleeve **3** fixedly attached on the exterior of the body.

FIG. 2 shows a prior art pour tube **1** having a slag-line sleeve **3** completely encapsulated in the body **2** of the pour tube.

FIG. 3 shows a prior art pour tube **1** having two slag-line sleeves, a first sleeve **3** comprising a highly erosion-resistant material and a second sleeve **4** comprised of a less erosion-resistant material, arranged so that the first sleeve **3** is sandwiched between the body **2** of the pour tube **1** and the second sleeve **4**.

FIG. 4 shows a pour tube 1 of the current invention having a body 2 with a slag-line sleeve 4 disposed within an interior cavity 13. An accommodation region 5, shown as a gap 6, exists in the region between the sleeve 4 and the body 2.

FIG. 5 shows a pour tube 1 of the current invention having an accommodation region 5 and vents 7 for the elimination of transient material.

FIG. 6 shows a pour tube 1 of the current invention where the slag-line sleeve 3 is covered by a third component 8 which is secured to the pour tube 1 by a fourth component 9.

[0020] An article of the present invention is shown in FIG. 4 and comprises a pour tube 1 having a body 2 with an interior cavity 13. A sleeve 4 is enclosed within the interior cavity 13.

[0021] An accommodation region 5 exists in the interior cavity 13 between the sleeve 4 and the body 2. In this embodiment, the accommodation region 5 is shown as a gap 6.

[0022] According to an embodiment of the invention, at least the outer surface 10 of the sleeve 4 is spaced from the body 2 by an accommodation region 5.

[0023] According to another embodiment of the invention, at least the top and/or bottom surfaces 11, 12 of the sleeve 4 is (are) spaced from the body 2 by an accommodation region 5.

[0024] In operation, the pour tube is subjected to extreme thermal gradients. The body of the pour tube insulates the annular sleeve from the resulting thermal shock and allows the sleeve's temperature to change only slowly, thereby reducing the likelihood that the sleeve will fracture. The accommodation region permits the sleeve to expand without fracturing the body.

[0025] The body comprises a material possessing good thermal shock-resistance, and includes, for example, alumina-graphite and fused silica refractories. Most commonly, the tube will be an alumina-graphite composition, ranging from about 45 to about 80 weight percent alumina with the balance comprising graphite. Preferably, the composition is about 62-67 wt.% alumina, about 20-25 wt.% graphite, with the balance comprising silica, zirconia, silicon, and other oxides. A suitable refractory for the body portion will generally have a coefficient of thermal expansion below about $6 \times 10^{-6}/°C$, and preferably about $4 \times 10^{-6}/°C$.

[0026] The sleeve is within the interior cavity of the pour tube, preferably at the slag-line. The shape of the sleeve will depend on several variables, such as the shape of the pour tube, the depth of immersion, and the depth of the slag. A sleeve will most commonly be cylindrical; however, it is anticipated that other shapes may be used, such as flat plates or asymmetric shapes. Reference to a sleeve will assume various shapes and should not be construed as limiting the sleeve to a cylindrical tube.

[0027] The sleeve must resist erosion caused by slag. Slag may comprise glasses, fluxes, oxides, mold powders, insulating powders or various impurities that float on the surface of molten steel during casting. The sleeve may comprise various erosion-resistant compositions including, for example, zirconia, titanates, nitrides, magnesia, dense alumina, and spinels of magnesia, alumina and graphite. Such compositions may be sintered or carbon-bonded. For example, carbon-bonded zirconia will comprise about 80-99.5 wt.% zirconia and about 0.5-20 wt.% carbon. A typical carbon-bonded composition contains 88 wt.% zirconia and 6 wt.% graphite. In contrast, sintered zirconia may be nearly pure zirconia with little or no graphite.

[0028] Erosion-resistant compositions used as slag-line sleeves typically have thermal expansion coefficients greater than $6 \times 10^{-6}/°C$. The difference in thermal expansion coefficients between the body and the sleeve causes the sleeve to expand with temperature more than the body. In practice, the sleeve often expands more than twice as much as the body. In prior art pour tubes, as shown in FIGs. 1, 2 and 3, thermal shock or thermal expansion may fracture the pour tube or the sleeve.

[0029] The present invention has an accommodation region between the sleeve and the body. This region permits expansion of the sleeve without fracturing the body or the sleeve. The region is defined as large enough that stresses caused by thermal expansion will not fracture the body or the sleeve. The region may be made large enough to accommodate the entire expansion of the sleeve. Obviously, the size of the region depends on a number of factors, including, but not limited to, the thermal expansions and geometries of the body and the sleeve, and the casting temperature of the steel.

[0030] The accommodation region may be a gap. The gap should be large enough to permit the sleeve to expand without placing unacceptable stress on the body of the pour tube. Conveniently, the gap is made large enough to accommodate thermal expansion of the sleeve at the temperature of casting. The accommodation region may also be a compressible material, instead of or in conjunction with a gap. As the sleeve expands, the compressible material compacts thereby minimizing stresses transmitted to the body. The compressible material should have a refractory composition, and most commonly will be a refractory fiber, for example, a ceramic fiber, such as silica or alumina. The compressible material may also advantageously secure the slag-line sleeve within the interior cavity.

[0031] The article of the present invention may be made by several methods. These methods may make use of a spacer material comprising a transient or compressible material. A transient material is any composition that can be eliminated from around a sleeve after pressing. Elimination of the transient material creates a gap between the body of the pour tube and the sleeve where the transient material had been. Transient materials may be eliminated by, for example, melting, volatilizing, combusting, degrading, or shrinking. Heat from the firing or actual use of the article may be used to effect these transitions. Transient materials may comprise metals, ceramics and organic compounds. Metals will typically be low melting point metals or alloys, such as lead. A ceramic may leave a gap between the sleeve and the body by, for example, shrinking as a result of sintering or degradation. Preferably, the transient material will be an organic material, such as wax, which can both melt and volatilize at elevated temperatures. In a preferred embodiment, as shown in FIG. 5, the body **2** of the pour tube **1** will have one or more vents **7**, which permit elimination of the transient material or its degradation products.

[0032] A compressible material may be used in conjunction with or independent of the transient material. The compressible material may expand to occupy the gap created by elimination of the transient material. Use of a compressible material may reduce or eliminate the need for vents. The compressible material should be a refractory fiber, such as a ceramic fiber, or an expanded refractory material.

[0033] The amount of spacer material required depends upon the disparity in thermal expansion and processing shrinkage between the body of the pour tube and the sleeve. A larger disparity suggests the use of a greater amount of spacer material. The spacer material should be present at least in sufficient amount to prevent fracture of the body by thermal expansion of the sleeve. Preferably, the amount of spacer material will fully compensate for the disparity. In other words, at casting temperatures, the sleeve will expand to completely fill the region between the body and the sleeve.

[0034] One method of making the article of the present invention involves placing a pre-shaped sleeve

inside a thermal shock-resistant, particulate, refractory body and subsequently pressing the sleeve within the body. Particulate means any type of material whether powdered, granular, fibrous, chunked, or any shape or combination of shapes, and of whatever size, which is amenable to being pressed into a form. The sleeve comprises an erosion-resistant refractory and may be prefired. The sleeve is coated with a spacer material before pressing within the body. The sleeve and body are pressed to form a piece, so that the refractory body is compacted around the sleeve. Preferably, the piece is isopressed, and most preferably the piece is isopressed on the inside and outside of the piece. The piece is then fired, and an interior cavity forms that is slightly larger than the sleeve so that a region is created between the body and the sleeve. The region may include a gap when the spacer material used to coat the sleeve comprises a transient material.

[0035] The article of the present invention may also be made by co-filling a mold with an erosion-resistant particulate refractory and a thermal shock-resistant particulate refractory. A guide means directs the erosion-resistant refractory to its proper place in the mold, that is, where the slag-line sleeve will be. The guide means is often a funnel, tube or annular form, but may be anything capable of directing a particulate into a mold. Often, a plurality of guide means are used. A spacer material is then introduced adjacent to the erosion-resistant refractory. Conveniently, the guide means may comprise the spacer material, such as, for example, wax slips. The filled mold is then pressed to form a piece and the piece is fired to produce the article. Pressing is most commonly done by isopressing. The firing temperature should be sufficiently high to densify the erosion-resistant refractory. Such a temperature is typically above 1300°C.

[0036] An alternative method for producing the article involves first creating an annular cavity within the thermal shock-resistant body of the pour tube. This may be done by forming an annular piece comprising a spacer material, typically an incompressible transient material such as wax or a low melting point metal. The annular piece is copressed with the thermal shock-resistant body. The spacer material is then substantially eliminated from the cavity, for example, by melting. The spacer material may also sublime, volatilize or otherwise be removed from the cavity. A refractory material having good erosion-resistance may then be inserted into the cavity. A representative composition includes zirconia or zirconia-graphite. Insertion is preferably accomplished using an injectable refractory. Injectable refractories comprise a particulate refractory with a transient flow agent, such as wax. Firing the resulting pour tube at elevated temperatures removes the transient flow agent and causes the refractory to shrink as carbon-bonding or sintering takes place. A suitable temperature for this process will be greater than about 1300°C. A gap is thereby formed between the injected erosion-resistant sleeve and the body of the pour tube. Care must be taken to achieve at least a minimum densification of the refractory for good erosion-resistance. It should be appreciated that injecting a refractory into a cavity of the pour tube may be used in other applications besides slag-line sleeves, for example, porous gas inserts.

[0037] Still another method of making the present invention, as illustrated by the article of FIG. 6, comprises securing a sleeve **4** onto a body **2** and encasing the sleeve **4** between the body **2** and a third component **8**. The sleeve may be fixedly secured to the body with mortar or may simply engage the body until the third component secures the sleeve in place. The third component may be a refractory piece designed to fit around the sleeve and the body while leaving a gap between the two. Alternatively, the third component may be a compressible material, such as refractory fiber. Both embodiments enable the sleeve to expand without creating destructive stresses in the body. Frequently, a fourth component **9** may be used to lock the third component **8** and the sleeve **4** in place. A fourth component is especially useful where the third component is a refractory fiber or would otherwise be difficult to mortar in place. Both the third and fourth components often comprise a plurality of pieces so as fit around the body.

<u>Example 1</u>

[0038] An erosion-resistant composition consisting essentially of zirconia is fired to form a cylindrical sleeve. The sleeve is then coated with wax to a thickness approximating the size of the sleeve at the casting temperature of steel. The coated sleeve is placed in a pour tube mold so that the sleeve encircles the flow passage and will be at the slag-line when the resultant pour tube is in operation. The sleeve is surrounded by a particulate alumina-graphite. The filled mold is pressed at 34.48 MPa (5000 psi), with pressure being applied on the inside and outside of the mold. The resultant piece is fired at greater than 800°C for greater than 2 hours. During firing the wax is eliminated and a gap is created between the sleeve and the body.

<u>Example 2</u>

[0039] Wax is formed into a cylindrical shape and placed in a pour tube mold around the flow passage and at the slag-line. The shape is surrounded by alumina-graphite. The filled mold is pressed at 34.48 MPa (5000 psi). A vent is created between the wax and the exterior surface of the pressed piece. The wax is melted out of the piece through the vent, thereby creating an interior cavity. A material comprising 80 wt.% zirconia and 20 wt.% wax is injected through the vent into the interior cavity. The piece is then fired at greater than 1300°C for greater than 5 hours. During firing the wax is eliminated, the zirconia densifies to form an erosion-resistant material, and a gap is created between the zirconia and the

body.

Example 3

[0040] A pour tube mold is co-filled with a particulate zirconia and an alumina-graphite refractory mix. The zirconia is directed into a pour tube mold at the slag-line using concentric funnels. An annular wax sleeve is placed inside of the zirconia around the flow passage. The zirconia alumina-graphite and wax sleeve are copressed at 34.48 MPa (5000 psi) and fired at greater than 1300°C for greater than 5 hours. During firing the wax is eliminated, the zirconia densifies to form an erosion-resistant material, and a gap is created between the zirconia and the body.

[0041] Obviously, numerous modifications and variations of the present invention are possible. It is, therefore, to be understood that within the scope of the following claims, the invention may be practiced otherwise than as specifically described.

Claims

1. An immersed pour tube (1) for molten metal comprising:

   (a) a body (2) comprising a refractory material, the body (2) having a flow passage for the molten metal and an interior cavity (13) surrounding at least part of the flow passage;
   (b) a sleeve (4) within the interior cavity (13) comprising an erosion-resistant refractory material,

   characterized in that the sleeve (4) is spaced from the body (2) by an accommodation region (5) sufficiently large to permit thermal expansion of the sleeve (4).

2. Pour tube according to claim 1, **characterized in that** at least the outer surface (10) of the sleeve (4) is spaced from the body (2) by an accommodation region (5).

3. Pour tube according to claim 1 or 2, **characterized in that** at least the top and/or bottom surfaces (11,12) of the sleeve (4) is (are) spaced from the body (2) by an accommodation region (5).

4. Pour tube according to any one of claims 1 to 3, **characterized in that** the sleeve (4) comprises over 80 wt. % of zirconia.

5. Pour tube according to any one of claims 1 to 4, **characterized in that** the body (2) has an exterior surface and at least one vent (7) communicating between the exterior surface and the interior cavity (13).

6. Pour tube according to any one of claims 1 to 3, **characterized in that** the accommodation region (5) comprises a gap (6) and/or a compressible material, preferably a refractory fiber.

7. Pour tube according to any one of claims 1 to 5, wherein the body (2) comprises a first component and a third component (8) Joined at an interface, **characterized in that** the interface defines the interior cavity (13).

8. Process for making an immersed pour tube (1) having a body (2) and an erosion-resistant sleeve (4) comprising the steps of :

   (a) forming an annular preform comprising an erosion-resistant refractory material;
   (b) coating the preform with a spacer material, preferably a transient material such as wax and/or a compressible material such as a refractory fiber to at least a thickness sufficient to create an accommodation region (5) sufficiently large to permit thermal expansion of the sleeve (4);
   (c) placing the preform in a particulate refractory body mix;
   (d) copressing the preform and the body mix to form an article;
   (e) firing the article sufficiently to produce a pour tube (1).

9. Process for making an immersed pour tube (1) having a body (2) and an erosion-resistant sleeve (4) comprising:

   (a) forming an annular preform comprising a transient material;
   (b) placing the preform in a particulate refractory body mix;
   (c) copressing the preform and the body mix to form an article;
   (d) removing the transient material, preferably by heating the article, whereby an interior cavity is created in the article;
   (e) injecting into the cavity an erosion-resistant refractory material;
   (d) firing the article sufficiently, preferably at a temperature greater than 1300°C, to densify the erosion-resistant refractory material and produce an accommodation region (5) sufficiently large to permit thermal expansion of the sleeve (4).

10. Process according to claims 8 or 9, **characterized in that** at least one vent (7) is provided for the escape of the transient material during firing.

11. Process for making an immersed pour tube (1) having a body (2) and an erosion-resistant sleeve (4) comprising:

(a) placing the sleeve (4) adjacent to an exterior surface of the body (2);
(b) covering the sleeve (4) with a third component (8), which forms an accommodation region (5) sufficiently large to permit thermal expansion of the sleeve (4) between the third component (8) and the sleeve (4); and
(c) attaching the third component (8) to the body (2).

12. Process for making an immersed pour tube (1) having a body (2) and an erosion-resistant sleeve (4) comprising:

(a) placing a particulate erosion-resistant refractory material within a pour tube mold at a location where the sleeve (4) will be;
(b) inserting a spacer material adjacent to the erosion-resistant material;
(c) filling the remainder of the mold with a body mix;
(d) pressing the filled mold to form a piece; and
(e) firing the piece at a temperature sufficient to densify the erosion-resistant material and form an accommodation region (5) sufficiently large to permit thermal expansion of the sleeve (4).

Patentansprüche

1. Eingetauchtes Gießrohr (1) für geschmolzenes Metall, umfassend:

(a) einen Körper (2), umfassend ein Feuerfestmaterial, wobei der Körper (2) einen Strömungskanal für das geschmolzene Metall und einen inneren Hohlraum (13) aufweist, der mindestens einen Teil des Strömungskanals umgibt;
(b) eine Manschette (4) innerhalb des inneren Hohlraums (13), die ein erosionsbeständiges Feuerfestmaterial umfasst,

dadurch gekennzeichnet, dass die Manschette (4) durch einen Anpassungsbereich (5), der groß genug ist, um eine Wärmedehnung der Manschette (4) zuzulassen, vom Körper (2) beabstandet ist.

2. Gießrohr nach Anspruch 1, **dadurch gekennzeichnet, dass** zumindest die Außenseite (10) der Manschette (4) durch einen Anpassungsbereich (5) vom Körper (2) beabstandet ist.

3. Gießrohr nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** zumindest die Ober- und/oder Unterseite (11, 12) der Manschette (4) durch einen Anpassungsbereich (5) vom Körper (2) beabstandet ist (sind).

4. Gießrohr nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Manschette (4) über 80 Gew.-% Zirkonerde umfasst.

5. Gießrohr nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** der Körper (2) eine Außenseite und mindestens eine Entlüftungsöffnung (7) aufweist, die eine Verbindung zwischen der Außenseite und dem inneren Hohlraum (13) herstellt.

6. Gießrohr nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** der Anpassungsbereich (5) einen Spalt oder Zwischenraum (6) und/oder ein kompressibles Material, vorzugsweise eine feuerfeste Faser, umfasst.

7. Gießrohr nach einem der Ansprüche 1 bis 5, bei dem der Körper (2) eine erste Komponente und eine dritte Komponente (8) umfasst, die an einer Grenzfläche verbunden sind, **dadurch gekennzeichnet, dass** die Grenzfläche den inneren Hohlraum (13) begrenzt.

8. Verfahren zur Herstellung eines eingetauchten Gießrohrs (1) mit einem Körper (2) und einer erosionsbeständigen Manschette (4), umfassend die Schritte:

(a) Bilden eines ringförmigen Vorformlings, der ein erosionsbeständiges Feuerfestmaterial umfasst;
(b) Beschichten des Vorformlings mit einem Abstandhaltermaterial, vorzugsweise einem Übergangsmaterial, wie Wachs, und/oder einem kompressiblen Material, wie einer feuerfesten Faser, bis mindestens zu einer Dicke, die ausreicht, um einen Anpassungsbereich (5) zu erzeugen, der groß genug ist, um eine Wärmedehnung der Manschette (4) zuzulassen;
(c) Platzieren des Vorformlings in einer teilchenförmigen Feuerfestkörpermischung;
(d) gemeinsames Pressen des Vorformlings und der Körpermischung, um einen Gegenstand zu formen;
(e) ausreichendes Brennen des Gegenstandes, um ein Gießrohr (1) zu erzeugen.

9. Verfahren zur Herstellung eines eingetauchten Gießrohrs (1) mit einem Körper (2) und einer erosionsbeständigen Manschette (4), umfassend:

(a) Bilden eines ringfömigen Vorformlings, der

ein Übergangsmaterial umfasst;
(b) Platzieren des Vorformlings in einer teilchenförmigen Feuerfestkörpermischung;
(c) Gemeinsames Pressen des Vorformlings und der Körpermischung, um einen Gegenstand zu formen;
(d) Entfernen des Übergangsmaterials, vorzugsweise durch Erwärmen des Gegenstandes, wodurch im Gegenstand ein innerer Hohlraum erzeugt wird;
(e) Einspritzen eines erosionsbeständigen Feuerfestmaterials in den Hohlraum;
(f) ausreichendes Brennen des Gegenstandes, vorzugsweise bei einer Temperatur von mehr als 1300°C, um das erosionsbeständige Feuerfestmaterial zu verdichten und einen Anpassungsbereich (5) zu erzeugen, der groß genug ist, um eine Wärmedehnung der Manschette (4) zuzulassen.

10. Verfahren nach den Ansprüchen 8 oder 9, **dadurch gekennzeichnet, dass** mindestens eine Entlüftungsöffnung (7) zum Entweichen des Übergangsmaterials während des Brennens vorgesehen ist.

11. Verfahren zur Herstellung eines eingetauchten Gießrohrs (1) mit einem Körper (2) und einer erosionsbeständigen Manschette (4), umfassend:

(a) Platzieren der Manschette (4) benachbart zu einer Außenseite des Körpers (2);
(b) Abdecken der Manschette (4) mit einer dritten Komponente (8), die einen Anpassungsbereich (5) bildet, der groß genug ist, um eine Wärmedehnung der Manschette (4) zwischen der dritten Komponente (8) und der Manschette (4) zuzulassen; und
(c) Befestigen der dritten Komponente (8) am Körper (2).

12. Verfahren zur Herstellung eines eingetauchten Gießrohrs (1) mit einem Körper (2) und einer erosionsbeständigen Manschette (4), umfassend:

(a) Platzieren eines teilchenförmigen erosionsbeständigen Feuerfestmaterials innerhalb einer Gießrohrform an einer Stelle, wo die Manschette (4) sein wird;
(b) Einbringen eines Abstandhaltermaterials benachbart zum erosionsbeständigen Material;
(c) Füllen des Rests der Form mit einer Körpermischung;
(d) Pressen der gefüllten Form, um ein Teil zu bilden; und
(e) Brennen des Teils bei einer Temperatur, die ausreicht, um das erosionsbeständige Material zu verdichten und einen Anpassungsbereich (5) zu bilden, der groß genug ist, um eine Wärmedehnung der Manschette (4) zuzulassen.

Revendications

1. Tube de coulée immergé (1) pour métal fondu comprenant:

a) un corps (2) comprenant un matériau réfractaire, le corps (2) ayant un canal de coulée pour le métal fondu et une cavité et une cavité intérieure (13) entourant au moins une partie du canal de coulée;
b) un manchon (4) dans la cavité intérieure (13) comprenant un matériau réfractaire résistant à l'érosion,

caractérisé en ce que le manchon (4) est espacé du corps (2) par une zone d'accommodation (5) suffisamment large pour permettre la dilatation thermique du manchon (4).

2. Tube de coulée suivant la revendication 1, **caractérisé en ce qu'au** moins la surface externe (10) du manchon (4) est espacée du corps (2) par une zone d'accommodation (5).

3. Tube de coulée suivant la revendication 1 ou 2, **caractérisé en ce qu'au** moins la surface supérieure et/ou inférieure (11,12) du manchon (4) est(sont) espacée(s) du corps (2) par une zone d'accommodation (5).

4. Tube de coulée suivant l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le manchon (4) comprend plus de 80% en poids de zircone.

5. Tube de coulée suivant l'une quelconque des revendications 1 à 4, **caractérisé en ce que** le corps (2) a une surface extérieure et au moins un évent (7) communiquant entre la surface extérieure et la cavité intérieure (13).

6. Tube de coulée suivant l'une quelconque des revendications 1 à 3, **caractérisé en ce que** la zone d'accommodation (5) comprend un vide (6) et/ou un matériau compressible, de préférence de la fibre réfractaire.

7. Tube de coulée suivant l'une quelconque des revendications 1 à 5, dans lequel le corps (2) comprend un premier composant et un troisième composant (8) jointifs à une interface, **caractérisé en ce que** l'interface définit une cavité intérieure (13).

8. Procédé pour faire un tube de coulée immergé (1)

ayant un corps (2) et un manchon (4) résistant à l'érosion comprenant les étapes de:

a) construire un préformé annulaire comprenant un matériau réfractaire résistant à l'érosion;
b) enduire le préformé avec un matériau d'espacement, de préférence un matériau transitoire tel que de la cire et/ou un matériau compressible tel que de la fibre réfractaire jusqu'à au moins une épaisseur suffisante pour créer une zone d'accommodation (5) suffisamment large pour permettre la dilatation thermique du manchon (4);
c) placer le préformé dans un mélange de particules réfractaires constituant le corps;
d) copresser le préformé et le mélange constituant le corps pour former un article;
e) cuire l'article suffisamment pour produire un tube de coulée (1).

9. Procédé pour faire un tube de coulée immergé (1) ayant un corps (2) et un manchon (4) résistant à l'érosion comprenant:

a) la mise en forme un préformé annulaire comprenant un matériau transitoire;
b) le placement du préformé dans un mélange de particules réfractaires constituant le corps;
c) le copressage du préformé et le mélange du corps pour former un article;
d) l'élimination du matériau transitoire, de préférence par chauffage de l'article, pour créer une cavité intérieure dans l'article;
e) l'injection dans la cavité intérieure d'un matériau réfractaire résistant à l'érosion;
f) la cuisson de l'article suffisamment, de préférence à une température supérieure à 1300°C, pour densifier le matériau réfractaire résistant à l'érosion et produire une zone d'accommodation (5) suffisamment large que pour permettre la dilatation thermique du manchon (4).

10. Procédé suivant la revendication 8 ou 9, **caractérisé en ce qu**'au moins un évent (7) est prévu pour l'évacuation du matériau transitoire durant la cuisson.

11. Procédé pour faire un tube de coulée immergé (1) ayant un corps (2) et un manchon (4) résistant à l'érosion comprenant:

a) le placement du manchon (4) adjacent à la surface extérieure du corps (2);
b) le recouvrement du manchon (4) avec un troisième composant (8), qui forme une zone d'accommodation (5) suffisamment large pour permettre la dilatation thermique du manchon (4) entre le troisième composant (8) et le manchon (4); et
c) la fixation du troisième composant (8) au corps (2).

12. Procédé pour faire un tube de coulée immergé (1) ayant un corps (2) et un manchon (4) résistant à l'érosion comprenant:

a) le placement des particules de matériau réfractaire résistant à l'érosion à l'intérieur d'un moule de tube de coulée à l'endroit où le manchon (4) se trouvera;
b) l'insertion d'un matériau d'espacement adjacent au matériau résistant à l'érosion;
c) le remplissage du reste du moule avec le mélange du corps;
d) le pressage du moule rempli pour former un article; et
e) la cuisson de l'article à une température suffisante pour densifier le matériau résistant à l'érosion et former une zone d'accommodation (5) suffisamment large pour permettre la dilatation thermique du manchon (4).

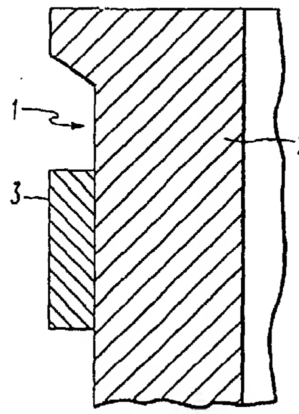

FIG.1
PRIOR ART

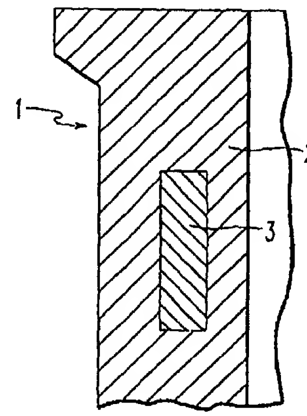

FIG.2
PRIOR ART

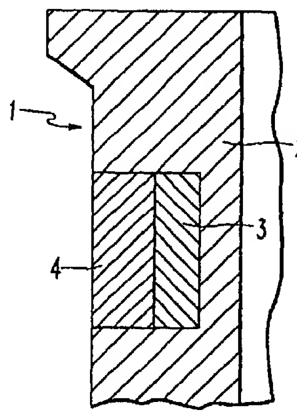

FIG.3
PRIOR ART

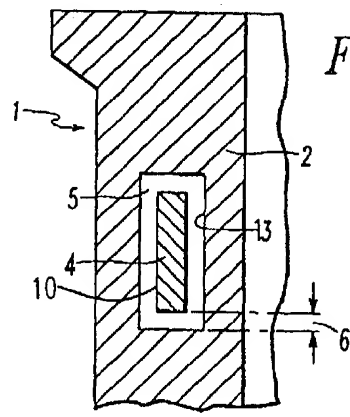

FIG.4

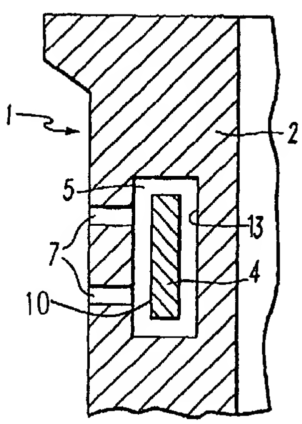

FIG.5

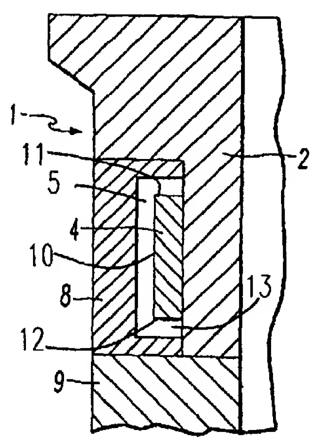

FIG.6